

Hawley's
Condensed Chemical
Dictionary

THIRTEENTH EDITION

Revised by
Richard J. Lewis, Sr.



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aeolotropic. (eolotropic). Displaying change of physical properties with change of position or direction, as in the change of refractive index on changing position of double refracting crystals: not isotropic.

AEPD. Abbreviation for 2-amino-2-ethyl-1,3-propanediol.

aerate. To impregnate or saturate a material (usually a liquid) with air or some similar gas. This is usually achieved by bubbling the air through the liquid, or by spraying the liquid into air.

"Aero" [Cytac]. TM; used as a combining form in naming a group of chemical products, e.g., "Aero-float." They include the following:

case-hardening mixtures	metal heat-treating salts
catalysts	metallurgical additives
fertilizer additives	anticaking agents
flotation agents	sizing emulsions
flocculants	wetting agents
frothing/foaming agents	reinforcing agents

aerobic. Requiring air or oxygen.
See bacteria.

aerogel. Dispersion of a gas in a solid or a liquid: the reverse of an aerosol. Flexible and rigid plastic foams are examples.
See foam; aerosol.

aerosol. A suspension of liquid or solid particles in a gas, the particles often being in the colloidal size range. Fog and smoke are common examples of natural aerosols; fine sprays (perfumes, insecticides, inhalants, antiperspirants, paints, etc.) are man-made.

aerosols. Suspensions of various kinds may be formed by placing the components together with a compressed gas in a container (bomb). The pressure of the gas causes the mixture to be released as a fine spray (aerosol) or foam (aerogel) when a valve is opened. This technique is used on an industrial scale to spray paints and pesticides. It is also used in consumer items such as perfumes, deodorants, shaving cream, whipped cream, and the like. The propellant gas may be a hydrocarbon (propane, isobutane) or dimethyl ether. Admixture of 15% of methyl chloride with the hydrocarbons reduces their fire risk; for this purpose water can be used with dimethyl ether. Carbon dioxide generated in situ is a propellant which does away with the flammability problem.

"Aerothene" [Dow]. TM for a group of chlorinated solvents used as vapor pressure depressants, or with compressed gases to replace fluorocarbon propellant systems.

"Aerothene TT" [Dow].

CAS: 71-55-6. TM for 1,1,1-trichloroethane solvent.

Use: Leather and suede cleaning.

aerazine. A 1:1 mix of hydrazine and uns-dimethylhydrazine (UDMH).

Hazard: Flammable and explosive.

Use: Rocket fuels.

See hydrazine.

AES. Abbreviation for Auger electron spectroscopy.

See spectroscopy.

AET. See aminoethylisothiurea dihydrobromide.

affilin. (*N*-isobutyl-2,6,8-decatienamide).

$C_{11}H_{21}NO$.

Properties: Yellowish, oily liquid. Bp 163°C (0.5 mm), mp 23°C, refr index 1.52. Soluble in alcohol; insoluble in alkalies and acids.

Derivation: From *Heliopsis longipes* or made synthetically.

Use: Insecticide activator.

affinity. The tendency of an atom or compound to react or combine with atoms or compounds of different chemical constitution. For example, paraffin hydrocarbons were so named because they are quite unreactive, the word *paraffin* meaning "very little affinity." The hemoglobin molecule has a much greater affinity for carbon monoxide than for oxygen. The free energy decrease is a quantitative measure of chemical affinity.

aflatoxins. A group of polynuclear molds (mycotoxins) produced chiefly by the fungus *Aspergillus flavus*; they are natural contaminants of a wide range of fruits, vegetables, and cereal grains.

Hazard: Highly toxic to many species of animals, including fish and birds. The B₂ and G₁ strains are known carcinogens. Aflatoxins fluoresce strongly under UV, and are soluble in methanol, acetone, and chloroform, but only slightly soluble in water and hydrocarbon solvents. Prevention of mold growth is the most effective protection; removal or inactivation is possible by physical or chemical means (hand-sorting, solvent refining, etc.). Complete elimination of aflatoxins from foods is not feasible; FDA sets an upper limit of 20 ppb in foods and feeds, and 0.5 ppb in milk.

See mycotoxin.

afterblow. In the Bessemer process, continuing the blast air flow in order to remove phosphorus after the removal of carbon.

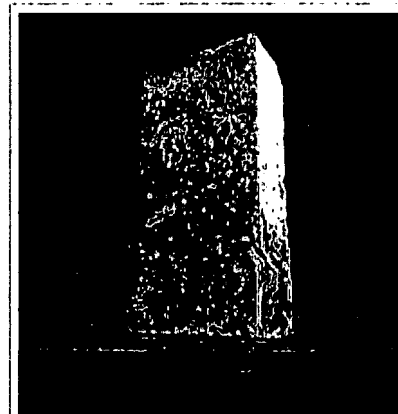
after-chromed dye. A dye that is improved in color or fastness by treatment with sodium dichromate, copper sulfate, or similar materials, after the fabrics are dyed.

Aerogel

From Wikipedia, the free encyclopedia

Aerogel is a low-density solid-state material derived from gel in which the liquid component of the gel has been replaced with gas. The result is an extremely low density solid with several remarkable properties, most notably its effectiveness as an insulator. It is nicknamed **frozen smoke**, **solid smoke** or **blue smoke** due to its semi-transparent nature and the way light scatters in the material; however, it feels like expanded polystyrene (Styrofoam) to the touch.

Aerogel was first created by Steven Kistler in 1931, as a result of a bet with Charles Learned over who could replace the liquid inside a jam (jelly) jar with gas without causing shrinkage.^{[1][2]} The first results were silica gels. Aerogel can be made of many different materials; Kistler's work involved aerogels based on silica, alumina, chromia, and tin oxide. Carbon aerogels were first developed in the early 1990s.^[3]



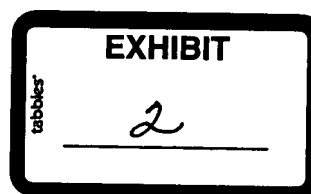
A 2.5 kg brick is supported by a piece of aerogel weighing only 2.38 grams.

Contents

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- 2 Types
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 - 2.3 Alumina aerogels
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Properties

To the touch, aerogels feel like a light but rigid foam, something between Styrofoam and the green floral foam used for arranging flowers. Despite what their name may suggest, aerogels are dry materials and do not resemble a gel in their physical properties but a nanofoam. (The name comes from the fact that they are derived from gels.) Pressing softly on an aerogel typically does not leave a mark; pressing more firmly will leave a permanent dimple. Pressing firmly enough will cause a catastrophic breakdown in the sparse structure, causing it to shatter like glass—a property known as *friability*. Despite the fact that it is prone to shattering, it is very strong structurally. Its impressive load bearing abilities are due to the dendritic microstructure, in which spherical particles of average size 2-5 nm are fused together into clusters. These clusters form a three-dimensional highly porous structure of almost fractal chains, with



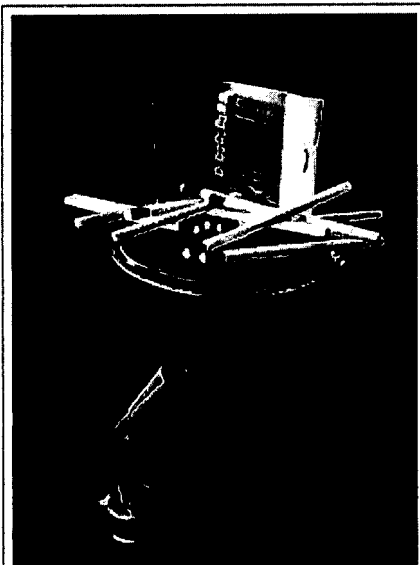
pores smaller than 100 nm. The average size and density of the pores can be controlled during the manufacturing process.

Aerogels are remarkable thermal insulators because they almost nullify three methods of heat transfer (convection, conduction, and radiation). They are good convective inhibitors because air cannot circulate throughout the lattice. Silica aerogel is an especially good conductive insulator because silica is a poor conductor of heat—a metallic aerogel, on the other hand, would be a less effective insulator. Carbon aerogel is a good radiative insulator because carbon absorbs the infrared radiation that transfers heat. The most insulative aerogel is silica aerogel with carbon added to it.

Due to its hygroscopic nature, aerogel feels dry and acts as a strong desiccant. Persons handling aerogel for extended periods of time should wear gloves to prevent the appearance of dry brittle spots on the hands.

Since it is mostly air, it appears semi-transparent. The color it does have is due to Rayleigh scattering of the shorter wavelengths of visible light by the nanosized dendritic structure. This causes it to appear bluish against dark backgrounds and whitish against bright backgrounds.

Aerogels by themselves are hydrophilic, but chemical treatment can make them hydrophobic. If they absorb moisture they usually suffer a structural change, such as contraction, and deteriorate, but degradation can be prevented by making them hydrophobic. Aerogels with hydrophobic interiors are less susceptible to degradation than aerogels with only an outer hydrophobic layer, even if a crack penetrates the surface. Hydrophobic treatment facilitates processing because it allows the use of a water jet cutter.



A demonstration of aerogel's insulation properties.

Types

Silica aerogels

Silica aerogel is the most common type of aerogel and the most extensively studied and used. It is a silica-based substance, derived from silica gel. The world's lowest-density solid is a silica nanofoam at 1 mg/cm^3 ^[4], which is the evacuated version of the record-aerogel of 1.9 mg/cm^3 ^[5]. The density of air is 1.2 mg/cm^3 .

Silica aerogel strongly absorbs infrared radiation. It allows the construction of materials that let light into buildings but trap heat for solar heating.

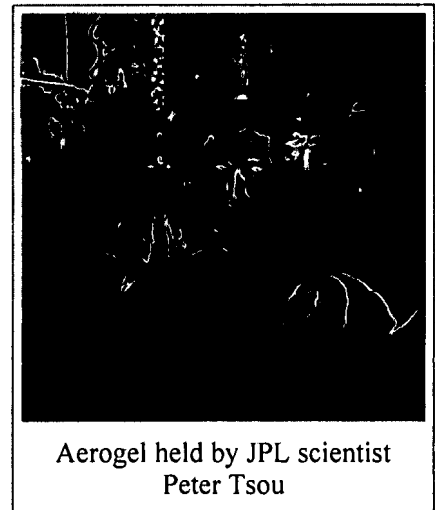
It has extremely low thermal conductivity ($0.03 \text{ W}\cdot\text{m/m}^2\cdot\text{K}$ down to $0.004 \text{ W}\cdot\text{m/m}^2\cdot\text{K}$),^{[6][4]} which gives it remarkable insulative properties. Its melting point is $1,473 \text{ K}$ ($1,200 \text{ }^\circ\text{C}$ or $2,192 \text{ }^\circ\text{F}$).

Silica aerogel holds 15 entries in the *Guinness Book of Records* for material properties, including best insulator and lowest-density solid.

Silica aerogel can protect the human hand from the heat of a blowtorch at point blank range.

Carbon aerogels

Carbon aerogels are composed of particles with sizes in the nanometer range, covalently bonded together. They have very high porosity (over 50%, with pore diameter under 100 nm) and surface areas ranging between 400–1000 m²/g. They are often manufactured as composite paper: non-woven paper made of carbon fibers, impregnated with resorcinol-formaldehyde aerogel, and pyrolyzed. Depending on the density, carbon aerogels may be electrically conductive, making composite aerogel paper useful for electrodes in capacitors or deionization electrodes. Due to their extremely high surface area, carbon aerogels are used to create supercapacitors, with values ranging up to thousands of farads based on a capacitance of 104 F/g and 77 F/cm³. Carbon aerogels are also extremely "black" in the infrared spectrum, reflecting only 0.3% of radiation between 250 nm and 14.3 μm, making them efficient for solar energy collectors.



Aerogel held by JPL scientist
Peter Tsou

The term "aerogel" has been incorrectly used to describe airy masses of carbon nanotubes produced through certain chemical vapor deposition techniques—such materials can be spun into fibers with strength greater than kevlar and unique electrical properties. These materials are not aerogels, however, since they do not have a monolithic internal structure and do not have the regular pore structure characteristic of aerogels.

Alumina aerogels

Aerogels made with aluminium oxide are known as alumina aerogels. These aerogels are used as catalysts, especially when "metal-doped" with another metal. Nickel-alumina aerogel is the most common combination. Alumina aerogels are also examined by NASA for capturing of hypervelocity particles; a formulation doped with gadolinium and terbium could fluoresce at the particle impact site, with amount of fluorescence dependent on impact velocity.

Other aerogels

SEAgel is a material similar to organic aerogel, made of agar.

Uses

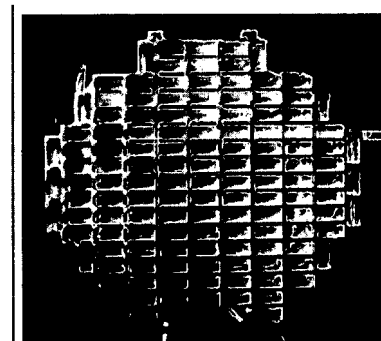
There are a variety of tasks for which aerogels are used. Commercially, aerogels have been used in granular form to add insulation to skylights.

After several trips on the *Vomit Comet*, one research team (<http://zerogaerogel.com/>) has shown that producing aerogel in a weightless environment can produce particles with a more uniform size and reduce the Rayleigh scattering effect in silica aerogel, thus making the aerogel less blue and more transparent. Transparent silica aerogel would be very suitable as a thermal insulation material for windows, significantly limiting thermal losses of buildings.

Its high surface area leads to many applications, such as a chemical absorber for cleaning up spills (see adsorption). This feature also gives it great potential as a catalyst or a catalyst carrier. Aerogel particles are also used as thickening agents in some paints and cosmetics.

Aerogels are being tested for use in targets for the National Ignition Facility.

Aerogel performance may be augmented for a specific application by the addition of dopants, reinforcing structures, and hybridizing compounds. Using this approach, the breadth of applications for the material class may be greatly increased.



The Stardust dust collector with aerogel blocks. (NASA)

Commercial manufacture of aerogel 'blankets' began around the year 2000. An aerogel blanket is a composite of silica aerogel and fibrous reinforcement that turns the brittle aerogel into a durable, flexible material. The mechanical and thermal properties of the product may be varied based upon the choice of reinforcing fibers, the aerogel matrix, and opacification additives included in the composite. One manufacturer of this aerogel composite may be found in the link below.

NASA used aerogel to trap space dust particles aboard the Stardust spacecraft. The particles vaporize on impact with solids and pass through gases, but can be trapped in aerogels. NASA also used aerogel for thermal insulation of the Mars Rover and space suits.^{[7][8]}

Aerogels are also used in particle physics as radiators in Cherenkov effect detectors. ACC system of the Belle detector, used in the Belle Experiment at KEKB, is a recent example of such use. The suitability of aerogels is determined by their low index of refraction, filling the gap between gases and liquids, and their transparency and solid state, making them easier to use than cryogenic liquids or compressed gases. Their low mass is also advantageous for space missions.

Resorcinol-formaldehyde aerogels (polymers chemically similar to phenol formaldehyde resins) are mostly used as precursors for manufacture of carbon aerogels, or when an organic insulator with large surface is desired. They come as high-density material, with surface area about 600 m²/g.

Metal-aerogel nanocomposites can be prepared by impregnating the hydrogel with solution containing ions of the suitable noble or transition metals. The impregnated hydrogel is then irradiated with gamma rays, leading to precipitation of nanoparticles of the metal. Such composites can be used as eg. catalysts, sensors, electromagnetic shielding, and in waste disposal. A prospective use of platinum-on-carbon catalysts is in fuel cells.

Aerogel can be used as drug delivery system due to its biocompatibility. Due to its high surface area and porous structure, drugs can be adsorbed from supercritical CO₂. The release rate of the drugs can be tailored based on the properties of aerogel.^{[9][10]}

Carbon aerogels are used in the construction of small electrochemical double layer supercapacitors. Due to the high surface area of the aerogel, these capacitors can be 2000 to 5000 times smaller than similarly rated electrolytic capacitors.^[11]

Dunlop tennis has recently incorporated Aerogel into the mold of its new series of racquets.

Production

Silica aerogel is made by drying a hydrogel composed of colloidal silica in an extreme environment. Specifically, the process starts with a liquid alcohol like ethanol which is mixed with a silicon alkoxide precursor to form a silicon dioxide sol gel (silica gel). Then, through a process called supercritical drying, the alcohol is removed from the gel. This is typically done by exchanging the ethanol for liquid acetone, allowing a better miscibility gradient, and then onto liquid carbon dioxide and then bringing the carbon dioxide above its critical point. A variant on this process involves the direct injection of supercritical carbon dioxide into the pressure vessel containing the aerogel. The end result removes all liquid from the gel and replaces it with gas, without allowing the gel structure to collapse or lose volume.

Aerogel composites have been made using a variety of continuous and discontinuous reinforcements. The high aspect ratio of fibers such as fiberglass have been used to reinforce aerogel composites with significantly improved mechanical properties.

Resorcinol-formaldehyde aerogel (RF aerogel) is made in a way similar to production of silica aerogel.

Carbon aerogel is made from a resorcinol-formaldehyde aerogel by its pyrolysis in inert gas atmosphere, leaving a matrix of carbon. It is commercially available as solid shapes, powders, or composite paper.

See also

- Gel
- Sol gel
- Hydrogel
- Xerogel
- SEAgel

Notes

- [^] Kistler S. S. (1931). "Coherent expanded aerogels and jellies". *Nature* **127** (3211): 741.
- [^] Kistler S. S. (1932). "Coherent Expanded-Aerogels". *Journal of Physical Chemistry* **36** (1): 52 - 64. DOI:10.1021/j150331a003 (<http://dx.doi.org/10.1021/j150331a003>).
- [^] Pekala R. W. (1989). "Organic aerogels from the polycondensation of resorcinol with formaldehyde". *Journal of Material Science* **24** (9): 3221-3227. DOI:10.1007/BF01139044 (<http://dx.doi.org/10.1007/BF01139044>).
- [^] ^a ^b Aerogels Terms (<http://www.llnl.gov/IPandC/technology/profile/aerogel/Terms/index.php>). LLNL.
- [^] "Lab's aerogel sets world record (<http://www.llnl.gov/str/October03/NewsOctober03.html>)". *LLNL Science & Technology Review*. October 2003.
- [^] Thermal conductivity from the CRC Handbook of Chemistry and Physics (<http://hbcnpnetbase.com/>), 85th Ed. section 12, p. 227
- [^] Preventing heat escape through insulation called "aerogel" (http://marsrovers.jpl.nasa.gov/mission/sc_rover_temp_aerogel.html), *NASA CPL*
- [^] Down-to-Earth Uses for Space Materials (<http://www.aero.org/publications/crosslink/fall2006/backpage.html>), *The Aerospace Corporation*
- [^] Smirnova I., Suttiruangwong S., Arlt W. (2004). "Feasibility study of hydrophilic and hydrophobic silica aerogels as drug delivery systems". *Journal of Non-Crystalline Solids* **350**: 54-60. DOI:10.1016/j.jnoncrysol.2004.06.031 (<http://dx.doi.org/10.1016/j.jnoncrysol.2004.06.031>).

10. ^ From the Research group Pharmaceutical Thermodynamics (http://www.tvt.cbi.uni-erlangen.de/eng/research/thermo_pharma/thermo_pharmazie_e.htm) of Friedrich - Alexander - University Erlangen - Nuremberg
11. ^ Aerogel Capacitors Support Pulse, Hold-Up, and Main Power Applications (http://powerelectronics.com/portable_power_management/batteries/power_aerogel_capacitors_support/)

References

From NASA's Stardust comet return mission on AEROGEL.
(<http://stardust.jpl.nasa.gov/tech/aerogel.html>)

- J. Fricke, A. Emmerling (1992). "Aerogels—Preparation, properties, applications". *Structure & Bonding* **77**: 37-87. DOI:10.1007/BFb0036965 (<http://dx.doi.org/10.1007/BFb0036965>).
- N. Hüsing, U. Schubert (1998). "Aerogels - Airy Materials: Chemistry, Structure, and Properties". *Angewandte Chemie International Edition* **37** (1/2): 22-196. DOI:<22::AID-ANIE22>3.0.CO;2-I 10.1002/1521-3773(19980202)37:1/2<22::AID-ANIE22>3.0.CO;2-I ([http://dx.doi.org/10.1002/1521-3773\(19980202\)37:1/2](http://dx.doi.org/10.1002/1521-3773(19980202)37:1/2)).
- Pierre A. C., Pajonk G. M. (2002). "Chemistry of aerogels and their applications". *Chemical Reviews* **102** (11): 4243 - 4266. DOI:10.1021/cr0101306 (<http://dx.doi.org/10.1021/cr0101306>).

External links

- NASA photos of aerogel (<http://stardust.jpl.nasa.gov/photo/aerogel.html>)
- Copy of Lawrence Berkeley National Laboratory page on the Thermal Properties of Silica Aerogels (<http://fourier.mech.virginia.edu/~microhx/thermalproperties.html>)
- Another LBL article covering the development of aerogels (<http://lbl.gov/Science-Articles/Archive/aerogel-insulation.html>)
- Aerogel FAQ at NASA JPL (<http://stardust.jpl.nasa.gov/overview/faq.html#aerogel>)
- Aerogel FAQ (<http://connectexpress.com/~ips/aerogel/faq.html>)
- Aerogel Jewelry by Aerogem—Includes Aerogel Photo Gallery (<http://aerogem.com/>)
- "A Solid That's Light As Air (<http://wired.com/news/technology/1,70268-1.html>)", by Dylan Tweney. *Wired*, 23 February 2006
- Aerogel insulates the The House of the Future? (<http://science.nasa.gov/newhome/help/tutorials/housefuture.htm>)
- American company researching and producing flexible aerogel blankets for insulation (<http://aerogel.com/>)
- Swedish company researching aerogel glass for windows (<http://www.airglass.se/>)
- Blog concerned with research, development and manufacture of double glazing insulating glass units with aerogel components (<http://insulatingglass.blogspot.com/>)
- Indian scientists develop an ultra light-weight aerogel material, which has the capacity to bear or support a weight five lakh times more than its own body weight. (http://timesofindia.indiatimes.com/Cities/Scientists_develop_aerogel/rssarticleshow/2030524.cms)

Retrieved from "<http://en.wikipedia.org/wiki/Aerogel>"

Categories: Insulators | Foams | Gels | Exotic matter

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Use: Thickener, thixotropic, and reinforcing agent in inks, resins, rubber, paints, cosmetics, etc. Base material for high-temperature mortars.
See "Aerosil"; "Cab-O-Sil."

silica fused. *See* silica; quartz, fused.

silica gel. A regenerative adsorbent consisting of amorphous silica. Noncombustible.

Derivation: From sodium silicate and sulfuric acid.

Grade: Commercial grades capable of withstanding temperatures up to 260–315°C are supplied in the following mesh sizes: 3–8, 6–16, 14–20, 14–42, 28–200, and through 325.

Use: Dehumidifying and dehydrating agent, air-conditioning, drying of compressed air and other gases and liquids such as refrigerants and oils containing water in suspension, recovery of natural gasoline from natural gas, bleaching of petroleum oils, catalyst and catalyst carrier, chromatography, anticaking agent in cosmetics and pharmaceuticals, in waxes to prevent slipping, in dietary supplements.
See silicic acid; "Britesorb" [PQ].

"Silic AR" [Mallinckrodt]. TM for silica-gel-based formulations suitable for various chromatographic applications. The numerical suffixes indicate the approximate pH of a 10% slurry. Letters F, G, or GF indicate that the product contains a fluorescent material, gypsum binder, or both. "TLC" indicates suitability for thin-layer chromatography.

silicate. Any of the widely occurring compounds containing silicon, oxygen, and one or more metals with or without hydrogen. The silicon and oxygen may combine with organic groups to form silicate esters. Most rocks (except limestone and dolomite) and many mineral compounds are silicates. Typical natural silicates are gemstones (except diamond), beryl, asbestos, talc, clays, feldspar, mica, etc. Portland cement contains a high percentage of calcium silicates. Best known of the synthetic (soluble) silicates is sodium silicate (water glass).

Hazard: (Natural silicate dusts) Toxic by inhalation.
Use: Fillers in plastics and rubber, paper coatings, antacids, anticaking agents, cements.

silicate garden. The irregular, colored, tubular growths formed in dilute aqueous silicate solutions by dropping water solutions of heavy metal salts into it.

silicic acid. (hydrated silica).

CAS: 7699-41-4. $\text{SiO}_2 \cdot n\text{H}_2\text{O}$. The jellylike precipitate obtained when sodium silicate solution is acidified. The proportion of water varies with the conditions of preparation and decreases gradually during drying and ignition, until relatively pure silica remains. During drying the jelly is converted to a white, amorphous powder or lumps.

Use: Laboratory reagent and reinforcing agent in rubber.

See silica gel.

silicochloroform. *See* trichlorosilane.

silicol. Silicic oxide casein metaphosphate.

silicomanganese. Alloys consisting principally of manganese, silicon, and carbon.

Use: Low-carbon steel in which silicon is not objectionable. Silicon manganese steels are used for springs and high-strength structural steels.
See ferromanganese.

silicomolybdic acid. *See* 12-molybdosilicic acid.

silicon. Si. Nonmetallic element. Atomic number 14, group IVA of the periodic table, aw 28.086, valence = 4, three stable isotopes. It is the second most abundant element (25% of the earth's crust) and is the most important semiconducting element; it can form more compounds than any other element except carbon.

Properties: Dark-colored crystals (the octahedral form in which the atoms have the diamond arrangement). The amorphous form is a dark-brown powder (*see* silicon, amorphous). D 2.33, mp 1410°C, bp 2355°C, Mohs hardness 7, dielectric constant 12, coordination number 6. Soluble in a mixture of nitric and hydrofluoric acids and in alkalies; insoluble in water, nitric acid, and hydrochloric acid. Combines with oxygen to form tetrahedral molecules in which one silicon atom is surrounded by four oxygen atoms. In this respect it is similar to carbon. It is also capable of forming —Si=Si— double bonds in organosilicon compounds.

Occurrence: Does not occur free in nature but is a major portion of silica and silicates (rocks, quartz, sand, clays, etc.).

Derivation: Crystalline silicon is made commercially (96–98% pure) in an electric furnace by heating SiO_2 with carbon, followed by zone refining. It can be purified to 99.7% by leaching. The ultrapure semiconductor grade (99.97%) is obtained by reduction of purified silicon tetrachloride or trichlorosilane with purified hydrogen; the silicon is deposited on hot filaments (800°C) of tantalum or tungsten. In a one-step method, sodium fluorosilicate is reacted with sodium, the heat produced being sufficient to form silicon tetrafluoride; this, when reacted with sodium, yields high-purity silicon and sodium fluoride. The process requires no heat except that provided by the original reaction. Single crystals of both n- and p-type are grown by highly specialized techniques.

Grade: Ferrosilicon, regular (97% silicon), semiconductor or hyperpure (99.97% silicon), amorphous.

Hazard: Flammable in powder form.

Use: Semiconductor in solid-state devices (transistors, photovoltaic cells, computer circuitry, rectifiers, etc.); organosilicon compounds; silicon carbide; alloying agent in steels, aluminum, copper,

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"Qiana" [Du Pont]. TM for a nylon-type synthetic fiber with properties similar to silk.

Q-lure. See cue-lure.

quad. An energy unit that has come into use in recent years in predicting future energy requirements on a national basis. One quad equals 10^{15} Btu, which is the energy equivalent of 10^{12} cu ft natural gas, or 182 million barrels of oil, or 42 million tons of coal, or 293 billion kilowatt-hours of electricity.

quadruple point. The temperature at which four phases are in equilibrium, such as ice, saturated salt solution, water vapor, and salt.

quadrupole resonance. See nuclear quadrupole resonance.

"Qualatex" [Colloids]. TM for synthetic latex. Use: Emulsions of acrylics, vinyl acetate, styrene, and butadiene for fabrics, nonwovens, adhesives, and coatings for paper and other materials.

qualitative analysis. See analytical chemistry.

quantitative analysis. See analytical chemistry.

quantization of energy. The assumption that the energy of a particle is not infinitely variable but can have any one of a definite set of values.

quantum efficiency. (photochemical yield). The number of electrons actually ejected per quantum of light absorbed.

quantum jump. See quantum transition.

quantum number. The quantum is the basic unit of electromagnetic energy. It characterizes the wave properties of electrons, as distinct from their particulate properties. The quantum theory developed by Max Planck states that the energy associated with any quantum is proportional to the frequency of the radiation, that is e (energy) = $h\nu$, where ν is the frequency and h is a universal constant.

An electron has four quantum numbers that define its properties. These are as follows: (1) The principal quantum number is a constant that can be any positive integer ($n = 1, 2, 3 \dots$). It determines the principal energy level, or shell, of the electron, sometimes designated by letters such as K, L, or M, depending on the value of the principal quantum number. (2) The angular momentum constant l , also

an integer, is related to n as $l = 0, 1, \dots, n - 1$. Here again, letter designations are often used. In s electrons, $l = 0$; in p electrons, $l = 1$; in d electrons, $l = 2$; and in f electrons, $l = 3$. (3) The magnetic quantum number, m , is an integer related to l as: $m = -1, \dots, -l, 0, +1, \dots, +l$. (4) The spin quantum number is independent of the other three and has a value of either $+1/2$ or $-1/2$, depending on the direction of rotation of the electron on its axis in the atomic frame of reference.

See orbital theory; electron; photon; radiation; Pauli exclusion principle.

quantum number, azimuthal. The quantum number specifying the angular momentum of an orbital electron.

quantum number, magnetic. The determinant of the component of angular momentum vector of an atomic electron or group of electrons along the externally applied magnetic field.

quantum number, radial. The radial motion quantum number that is an integer for any permitted stationary condition of a particle moving under the influence of a central field.

quantum state. (energy level). The energy state of an atom as determined by the frequencies of its characteristic spectral lines.

quantum transition. (quantum jump). The sharp change in an atom accompanied by emission or absorption of a quantum of radiant energy.

quantum yield. Number of photon-induced reactions of a specified type per photon absorbed.

quark. The smallest known bit of matter. Hypothetical entities carrying electrical charges of one-third or two-thirds the normal unit. Light (300 MeV), hypothetical particles used to facilitate calculation of certain observables.

quartz.

CAS: 14808-60-7. SiO_2 . Crystallized silicon dioxide (silica).

Properties: White to reddish color, vitreous luster. Mp 1713C, Mohs hardness 7, d 2.65. Insoluble in acids except hydrogen fluoride; only slightly attacked by solutions of caustic alkali. Piezoelectric and pyroelectric. Noncombustible.

Derivation: Synthetic crystals of good size and purity are grown by mass production methods under

very carefully regulated conditions of temperature and concentration.

Hazard: Avoid inhalation of fine particles. TLV: (for respirable dust) 10 mg/m³/1% respirable quartz + 2.

Use: Electronic components; piezoelectric control in filters, oscillators, frequency standards, wave filters, radio and TV components; barrel-finishing abrasive.

See silica.

quartz, fused. Pure silica that has been melted to yield a glasslike material on cooling.

Use: For apparatus and equipment (such as vacuum tubes) where its high melting point, ability to withstand large and rapid temperature changes, chemical inertness and transparency (including UV radiation), and electrical resistance are valuable. Produced as fibers and fabrics for heat resistance, low expansion coefficient, and insulating value.

See glass.

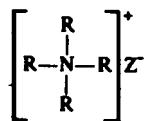
quassia. (bitter ash; bitterwood).

Properties: White to bright-yellow chips or shavings; very bitter taste.

Derivation: The wood or bark of *Picrasma excelsa* or *Quassia amara*.

Use: Decoction or tincture as a fly poison, surrogate for hops, medicine (anthelmintic), hair lotion, flavoring, alcohol denaturant.

quaternary ammonium salt. A type of organic nitrogen compound in which the molecular structure includes a central nitrogen atom joined to four organic groups (the cation) and a negatively charged acid radical (the anion). The structure is indicated as:



Octadecyldimethylbenzyl ammonium chloride and hexamethonium chloride are examples. Pentavalent nitrogen ring compounds, such as lauryl pyridinium chloride, are also considered quaternary ammonium compounds. They are all cationic, surface-active coordination compounds and tend to be adsorbed on surfaces.

Use: Disinfectant, cleanser and sterilizer, cosmetics (deodorants, dandruff removers, emulsion stabilizers), fungicides, mildew control, to increase affinity of dyes for film in photography, coating of pigment particles to improve dispersibility, to increase adhesion of road dressings and paints, antistatic additive, biocide.

See detergent, synthetic; coordination compound.

p-quaterphenyl. C₆H₅C₆H₄C₆H₄C₆H₅.

Properties: Crystals. Mp 316–318C, bp 428C (18 mm Hg).

Grade: Purified.

Use: As primary fluor or as wavelength shifter in soluble scintillators.

quebrachine. See yohimbine.

quebracho.

Properties: A wood-derived tannin, the most important tanning agent used in the American leather industry. Combustible.

Derivation: From *Aspidosperma quebracho* and *Quebracho lorentzi*, imported as logs from Argentina.

Grade: Liquid: 35–37% tannin. Solid: 65% tannin.

Use: Vegetable tanning, retanning of chrome-tanned upper leathers, dyeing, ore flotation, oil-well drilling fluids, flavoring.

Quelet reaction. Passage of dry hydrogen chloride through a solution in ligroin of a phenolic ether and an aliphatic aldehyde in the presence or absence of a dehydration catalyst to yield α -chloroalkyl derivatives by substitution in the *para* position to the ether group or in the *ortho* position in *para*-substituted phenolic ethers.

quench. In the terminology of metallurgy, quick cooling of metals or alloys by immersion in cold water or oil. This is an essential part of the tempering process, especially for steels. If the metal or alloy is in the liquid (molten) state and the quench time is extremely short (less than a second), the product will have an amorphous or glasslike structure, because no crystallization occurs.

See glass, metallic.

quercetin.

CAS: 117-39-5. C₁₅H₁₀O₇.

Properties: Yellow needles (dihydrate). Anhydrous form decomposes at 315C. Soluble in alcohol and glacial acetic acid; insoluble in water.

Derivation: Bark of fir trees, also synthetically.

Use: Medicine, reported formation of epoxy resins on mixing with epichlorohydrin.

"Questex" [Stauffer]. TM for ethylenediamine-tetraacetic acid (EDTA) and derivatives, a group of poly-amino-acid-based organic sequestering agents that complex or chelate multivalent, metallic cations (such as calcium, magnesium, copper, and iron) into stable, coordinated anionic complexes.

quick-. Prefix meaning alive or active, as in quicksilver (mercury), quicklime (unslaked lime), quicksand, quick (the flesh beneath the fingernail).

quicklime. See calcium oxide.

quicksilver. See mercury.